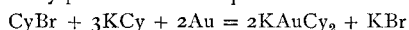


diminishes slowly as the concentration is increased, and rapidly if it is decreased.

These results are in perfect accord with the experience gained in practice on a large scale. Before MacLaurin's papers were published, the favourite stock solution in South Africa had for some time been one containing from 0.25 to 0.30 per cent. of cyanide, although weaker solutions are also used with excellent effect. Moreover, the difficulties introduced by a lack of free oxygen in the ore have long been severely felt. In particular, when concentrates containing much pyrites are treated, the absorption of oxygen by the sulphides is so rapid that the dissolution of gold is soon checked and becomes extremely slow. Thus, while gold-leaf floating on cyanide solutions is dissolved in a few minutes, and, if submerged, in a few hours, the films of gold in pyrites, which are probably similar in thickness to gold-leaf, often take two or three weeks in going into solution.

This is so far from satisfactory that many efforts have been made to increase the speed of action of cyanide in some way. An artificial supply of oxygen, or air forced through the charge of ore and solution, was found to shorten the time required but to increase the waste of cyanide, and similar results follow from the use of various oxidising agents, such as manganese dioxide, hydrogen peroxide, and bleaching powder.

Greater interest attaches to the proposal made by Sulman and Teed to add bromide of cyanogen to ordinary cyanide solutions (Trans. of the *Inst. of Mining and Metallurgy*, vol. iii. (1895), p. 202). They put forward the equation

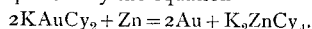


as expressing the action which takes place, but no direct proof has yet been afforded of the validity of this equation. These experimenters are, however, convinced that oxygen plays no part in the action, and, consequently, that except for the fact that the edges only of the films of gold in pyrites are presented for attack, solution of the gold in concentrates is as rapid as that in quartzose ores. This view is borne out by a number of trials on half-ton lots of ore, although no results of actual working have yet been published. Even when there is full access of air, however, as in the case of gold-leaf floating on the solution, the addition of cyanogen bromide greatly increases the rate of action of potassium cyanide, and if air and bromine are together passed through a solution of cyanide, the rate is increased about 100 times.

Slowness of action in dissolving gold is of more importance than may at first sight appear, for it must be remembered that alkaline cyanides attack many of the constituents of gold ores at varying rates, and, therefore, that the longer the solution is left in contact with the ore, the greater will be the decomposition of the cyanide, and, consequently, the greater the total cost of the process. Decomposing pyrites (especially if sulphide of copper is present) are, when not in perfect contact with gold, particularly active in destroying cyanide, and, in order to partially prevent their effect, it is customary to neutralise ores which have been rendered acid by the formation of sulphates by "weathering." The neutralisation is effected by the addition of a solution of caustic soda, or, more usually, of lime to the ore before it is treated with cyanide. The destruction of cyanide, however, still goes on to a limited extent in such cases, and treatment is rendered practicable only by the preferential or more rapid action of very dilute solutions of cyanide on gold as compared with their action on the sulphides.

The relative rates of action of cyanogen bromide on gold, and on the various sulphides and oxides met with in ores, remain undetermined, or at any rate unpublished, and until more light is thrown on these, either by laboratory experiments or by practical work on a large scale, it is impossible to judge what may be the future of the process. From some experiments, already made, it would appear that cyanogen bromide suffers considerable decomposition when placed in contact with some of the minerals met with in gold ores, and so it may happen that in many cases the haloid compound will be destroyed before it has time to get fairly to work in dissolving the gold.

The gold is recovered from solution either by its precipitation and replacement in solution by a metal positive to it in cyanide solutions, or by electro-deposition. The only metal largely used in practice is zinc, the action being one of direct replacement, expressed by the equation



It has been found necessary to use the zinc in a fine state of division, and the filaments, prepared by turning zinc in a lathe,

are certainly more efficient than other forms. The shavings are no more than 0.1 m.m. in thickness, and 0.5 m.m. in width. When packed in spongy form they weigh about six or seven lbs. per cubic foot and can be ignited by a lucifer match, burning readily to zinc oxide. They must be freshly turned, as in practice the cyanide solutions are too dilute to clean dirty surfaces by dissolving hydrates or carbonates of zinc.

The action of the zinc is undoubtedly aided by the presence of lead, which exists as an impurity in commercial zinc to the extent of about 1 per cent., and by the iron gratings on which the filaments rest. Galvanic couples are thus formed, which assist in starting the action. Nevertheless, precipitation of the gold is at first slow, especially in very dilute solutions, and it is only after some gold has been thrown down, and the gold-zinc couple formed, that the action becomes fairly vigorous. When the amount of gold in solution has fallen to about 0.0003 per cent., or from $1\frac{1}{2}$ to 2 dwts. per ton of liquid, the action again becomes slow, and this amount is left unprecipitated in practice, but, as the solutions are used again on fresh charges of ore, no loss of gold occurs.

The black slimy deposit of gold, or alloy of gold and zinc thus formed, is washed and sieved off from the undecomposed zinc as far as possible, and is dried, roasted, and melted down with borax, carbonate of soda, and other fluxes, with or without a previous treatment with dilute sulphuric acid. The bullion thus obtained is very base, containing about 700 of gold per 1000, and variable quantities of zinc, lead, copper, and other metals. It is subject to the disadvantage that assay pieces, taken in the ordinary way, frequently differ in composition from the ingot taken as a whole.

The recovery of the gold from cyanide solutions by electro-deposition is the basis of the Siemens-Halske process. In this process the kathodes are of iron, and the anodes of lead foil. A very large surface is given to the electrodes, 12,000 square feet of surface of lead being exposed in the treatment of 70 tons of solution per day at the Worcester Mine in the Transvaal. At stated intervals, the lead anodes, containing from 2 to 12 per cent. of gold, are removed, melted down, and cupelled. The bullion produced is very fine, but the cost of precipitation appears to be greater than that by the zinc process, the main items being the lead and iron consumed. The current needed is only about 0.06 ampere per square foot, the power required being about 5 h.p. in the treatment of 70 tons of solution per day. The process makes but slow progress, only a small proportion of the gold produced by cyanide on the Rand being obtained in this way. T. K. ROSE.

AGRICULTURAL TEACHING AT OXFORD.¹

THE present Professor of Rural Economy at Oxford has made use of the opportunity, afforded by the occurrence of the centenary of the foundation of his professorship, to discuss the general question of agricultural teaching in our Universities. After an interesting description of the life and work of Sibthorp, formerly Professor of Botany at Oxford, who literally gave up his life for the study of natural history on the shores of Greece, Prof. Warrington proceeds, in the first place, to consider the important developments, both in the subject and in the means of teaching, which have taken place during the past century. He says:—

"The point on which I want to fix attention is the wholly different position in which agriculture stands at the present day from that which it held a hundred years ago. A hundred years ago agriculture was an art, having few points of contact with natural science. At the present time, both the materials and the operations of agriculture have been so far examined and elucidated by patient scientific investigation, that we may now fearlessly give the title of 'Agricultural Science' to the edifice of true theory which has been constructed. We need not shrink from making this claim because the theoretical edifice is still incomplete, for this incompleteness of theory is the normal condition of the natural sciences; what we assert is, that the whole field of agriculture is now occupied by the

¹ "Agricultural Science: its place in a University Education." A lecture delivered before the University of Oxford, on November 5, 1896, on the occasion of the centenary of the foundation by Dr. John Sibthorp of the chair of Rural Economy, by Robert Warrington, M.A., F.R.S., Sibthorpian Professor of Rural Economy. (London: Henry Frowde, 1896.)

scientific investigator, and that it is only a question of time when the problems still awaiting solution will cease to puzzle us."

This important change in the character of the subject is made the foundation of a claim for its fuller recognition by the University.

"In considering what should be the place of agriculture in University teaching, it is of primary importance that we should grasp the fact of the existence of this great body of agricultural science which has grown up during the last century. If agriculture is still merely an art, it has no proper place in University teaching, and those who wish to learn it must resort to some technical school for the purpose. If, on the other hand, agriculture is now as much a department of science as geology or medicine, it has an undoubted claim to be recognised, and its claim becomes urgent when we consider the vast importance of the subject."

The most important steps which have been taken in the development of agricultural teaching are then noticed, especial emphasis being laid on the great extension of such teaching during the last ten years, chiefly through the exertions of the County Councils and the Board of Agriculture. Not only have the means of instruction been greatly increased, there has also been a remarkable growth of opinion among the higher class of agriculturists as to the value of a thoroughly scientific training in the department of agriculture. Thus, in February 1893, the Council of the Royal Agricultural Society passed the following resolution:—"That, in the opinion of the Royal Agricultural Society of England, it is desirable that provision be made in all Universities for the granting of a degree in Science for students of agriculture." The same Society gave evidence before the Royal Commission on the proposed Gresham University for London, and urged that a degree for students in Agriculture should be given by the new University.

Prof. Warington next proceeds to mention what is being at present done in the way of agricultural teaching by British Universities and University Colleges. It appears that the Universities of Edinburgh, Glasgow, Aberdeen, Durham, and Wales, all grant the degree of B.Sc. in Agriculture to students who have successfully passed examinations in agriculture and in the sciences connected therewith. The scheme for agricultural instruction at Cambridge did not succeed in passing the Senate; this University now grants a diploma in Agriculture, the examination for which is open to all-comers. About one half of the University Colleges in England give a complete course of agricultural teaching. Besides these, there are the purely agricultural colleges, to which many additions have recently been made by the County Councils.

The question is then asked, Does this great extension of agricultural teaching in recent years meet all our requirements? The answer is that it does not.

"A real effort is being made to instruct and elevate the farmer and the more intelligent of the labouring class, while the landowner, who finds his education at Oxford or Cambridge, is left without the opportunity of fitting himself for his subsequent duties, and consequently cannot be expected to act the part of a wise leader in the march of improvement which has become so necessary. In the Universities of Oxford and Cambridge there are, I suppose, about 5000 undergraduates, of whom a considerable proportion will in after life have the management of land. A proper provision for the teaching of agriculture in these Universities would, I believe, do far more to improve the condition of agriculture in this country than is effected by all the Government grants distributed by the Board of Agriculture."

Prof. Warington considers, in conclusion, what may be usefully done at Oxford in the direction just indicated. The twelve annual lectures required by statute from the Sibthorpe Professor, unconnected as they are with any examination or degree, are productive of little good. He does not ask that the University should institute a degree in Agriculture, or even that they should at present deal with the subject in any large or comprehensive way. The proposal is that Agricultural Science should be placed among the science subjects, of which two may be selected as part of the final examination for a Pass degree. This plan would merely require the provision of additional lectures, so that agricultural science might be taught throughout the whole academic year. If this modest scheme were adopted the agricultural teaching would become effective, being tested by examination, and leading to that goal of all University men—a degree.

We do not wish to express an opinion on the details of a University scheme; but we heartily wish success to Prof. Warington's proposal. The function of a University is the education of the mind, and the propagation of knowledge; and such an important branch of knowledge as agricultural science should certainly find a place in our schemes of University education.

DR. KOCH'S REPORTS ON RINDERPEST.

THREE reports have now been published by Dr. Koch on Rinderpest. The *Cape of Good Hope Agricultural Journal* for January 14, reprints the first two, whilst the third has appeared in the weekly edition of the *Cape Times* of February 10. The first is dated December 9, four days after Dr. Koch arrived at Kimberley, and the second and third, January 3 and 31 respectively. All hail from Kimberley, which city Dr. Koch has made his headquarters for the present. The scientific experiment station, which has been arranged and fitted up for him, is situated about two miles out. Dr. Edington's research station is at Taungs, where it is stated that the inhabitants have lost as many as 20,000 head of cattle from the pest. It will be remembered that Dr. Edington has discovered and cultivated certain micro-organisms which he believes to be the virus of cattle plague, and Dr. Koch is carrying out some experiments with cultures, placed at his disposal by Dr. Edington, to ascertain what, if any, part is played by them in the disease. Elaborate precautions have had to be taken at the Victorian Compound, Dr. Koch's station, to avoid accidental infection of the animals under observation, which would entirely vitiate the inquiry. Dr. Koch provided himself with blood and other materials obtained from plague-stricken animals, and with these he has already carried out a large number of inoculation experiments. In the first instance an efficient method had to be discovered of infecting animals artificially with the disease, for the methods hitherto employed were not attended with the desired success. Koch, instead of using the secretions of infected animals, has employed hypodermic injections of blood taken from rinderpest victims, and this method has proved extremely successful. All efforts so far to find, whether by cultivation, or microscopical examination, a specific micro-organism in the blood have proved fruitless; neither has any specific microbe been discovered among those abundantly present in the mucus from the nose, the secretions, and other mucous membranes. Dr. Koch has no intention of abandoning the search, but at present his efforts are concentrated upon finding a process which may attenuate the virus of rinderpest, so as to transform it into an antidote. The first steps in this direction were made by inoculating animals, such as sheep and goats, less susceptible to the disease than other cattle, with rinderpest blood. The symptoms, consequent upon these inoculations, resembled those of a mitigated attack of rinderpest; the blood of these animals inoculated into other sheep and goats also induced symptoms of mild rinderpest, and the hope was raised that after these inoculations had been continued through further generations, the blood of these animals might induce a modified attack of the disease in cattle. This hope proved, however, illusory, for cattle succumbed rapidly to rinderpest after such inoculations. Dr. Koch has also been endeavouring to produce an attenuated virus by chemical and physical means. Rinderpest blood mixed with glycerine appears to suffer some abatement of its virulence, whilst even better results followed the addition of phenol to the virus. Cows inoculated with rinderpest blood and phenol did not contract the disease; moreover, when subsequently inoculated with virulent blood, they remained healthy. These experiments are being continued. A most noteworthy experiment was, however, the dessication of rinderpest blood at a temperature of 31° C. during a period of four days. A head of cattle inoculated with this blood dissolved in water remained perfectly healthy. Unfortunately, however, although the inoculation produced no effect upon the animal, it also afforded it no protection from subsequent infection with fresh rinderpest blood. Of all the animals which have been infected with rinderpest blood at the experimental station, only four have recovered, and Dr. Koch has used them for ascertaining whether the blood of immune animals, for they did not contract the disease when reinoculated, possesses any protective power. The results were encouraging, for this blood certainly did exert a distinct immunising action; but it remains to be seen